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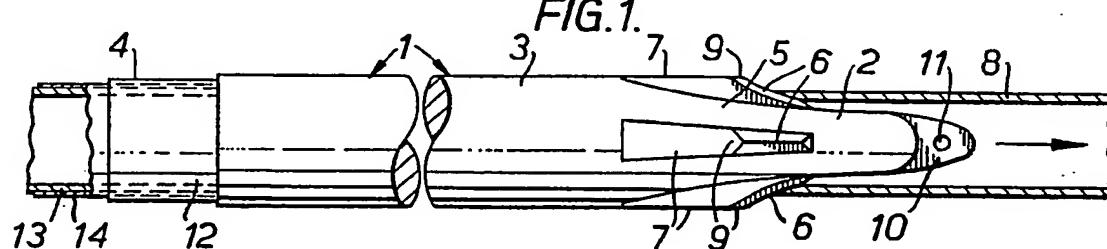
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1977  
(71) Applicant,  
British Gas Corporation  
(United Kingdom),  
152 Grosvenor Road,  
London SW1V 3JL,  
D. J. Ryan and Sons Ltd.

(United Kingdom),  
Inglewhite Road,  
Longridge, Preston  
PR3 2DA  
(72) Inventor  
Francis Donald Wilson  
(74) Agent and/or Address for  
Service  
David J. Morgan,  
Patents Dept., British Gas  
Corporation, 326 High  
Holborn, London  
WC1V 7PT

(54) Replacing mains

(57) An existing main is replaced or  
prepared for replacement with a new  
main by fracturing the existing main  
and maintaining sufficient clearance  
through the fractured main for  
movement therethrough of a new  
main. The mole or a liner for the

fractured main, the liner to serve as a  
protective sleeve for the new main  
when the new main is subsequently  
moved into the liner, which is of steel,  
is adapted to be inserted into and  
moved along the existing main 8. The  
mole has a front portion comprising a  
head 2 and a cylindrical body portion  
3 and a rear portion having clamping  
means 4 for clamping a new main 13.  
The head 2 has a cutting face 5 for  
engaging the internal wall of the  
existing main so as to cause the wall  
to fracture as the mole moves  
theralong. The new main which in  
use is clamped to the mole is towed  
along behind the mole to replace the  
fractured old main. The cutting face 5  
comprises cutting edges 6 formed by  
grinding on high tensile steel cutters 7  
which are located in keyways in the  
head 2.



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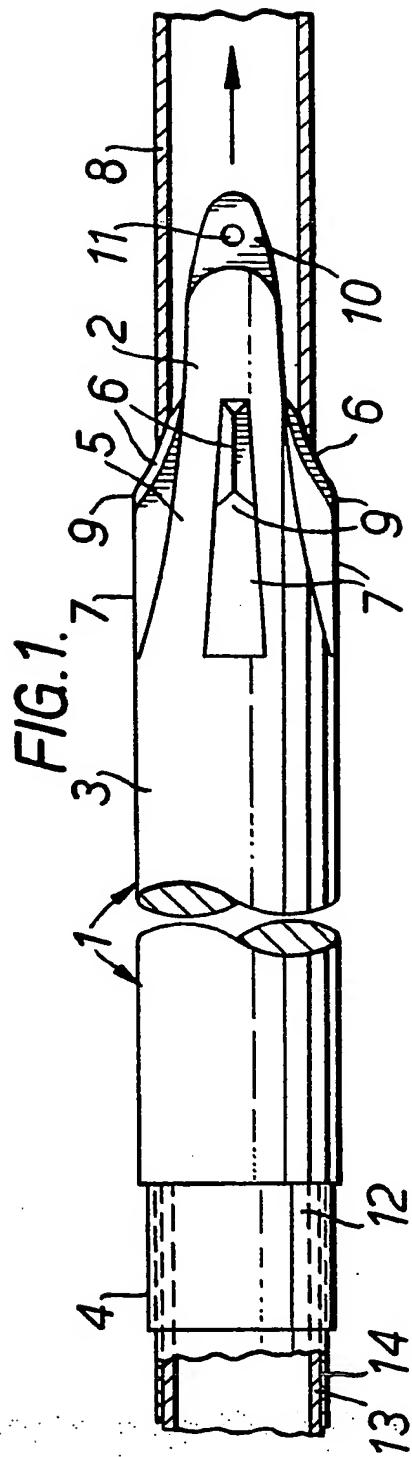


FIG. 3.

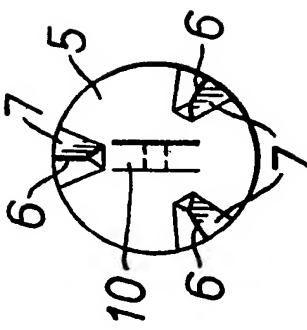
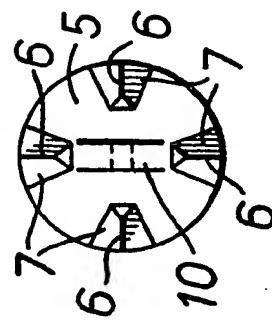


FIG. 2.



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FIG. 4.

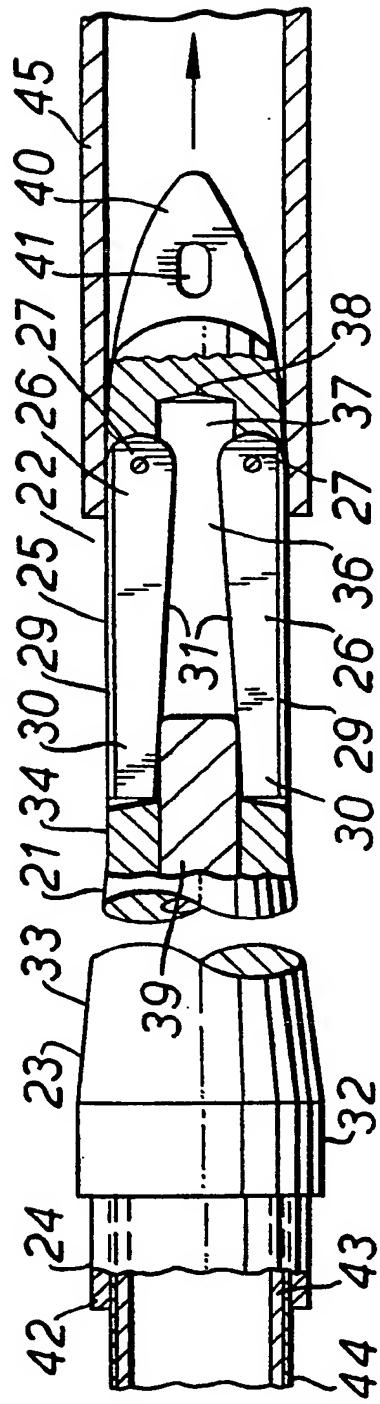
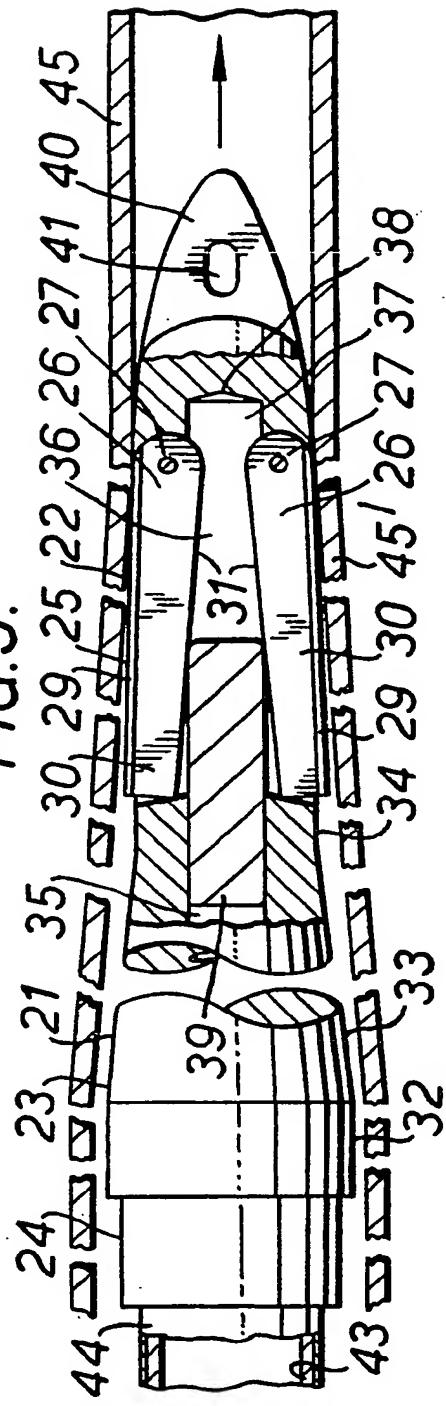


FIG. 5.



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FIG. 6.

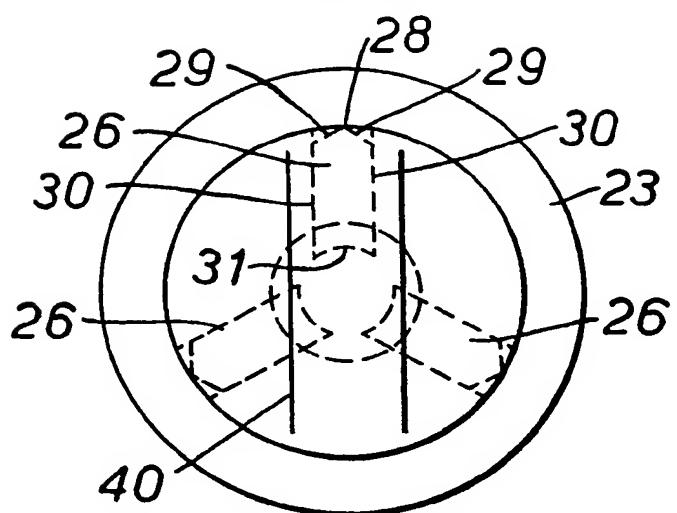
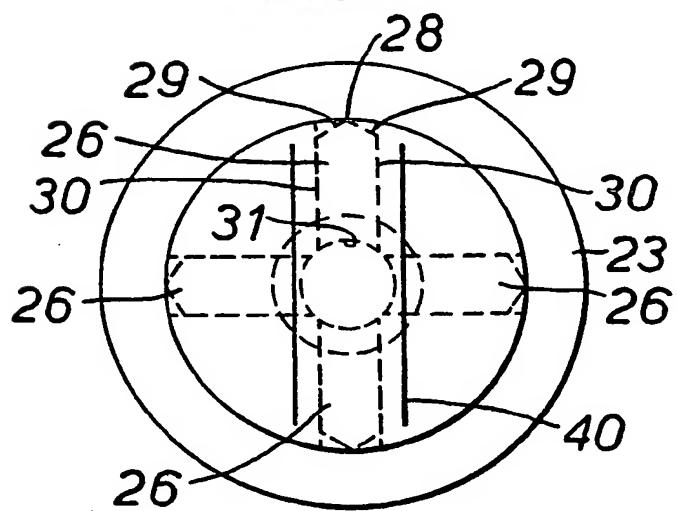


FIG. 7.



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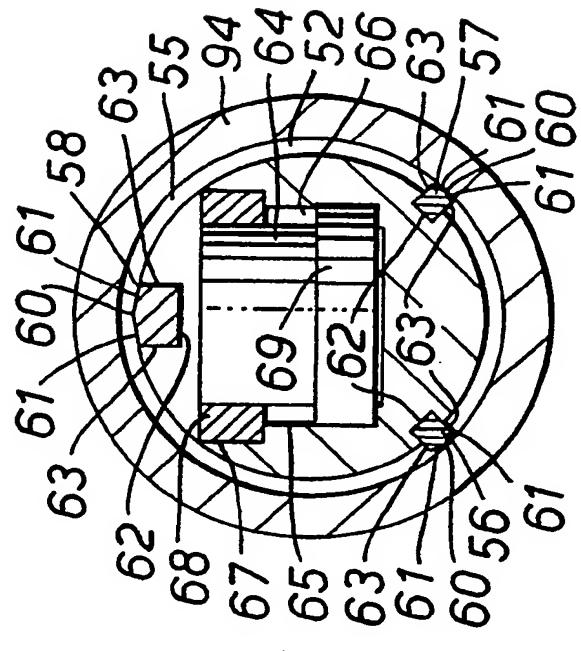
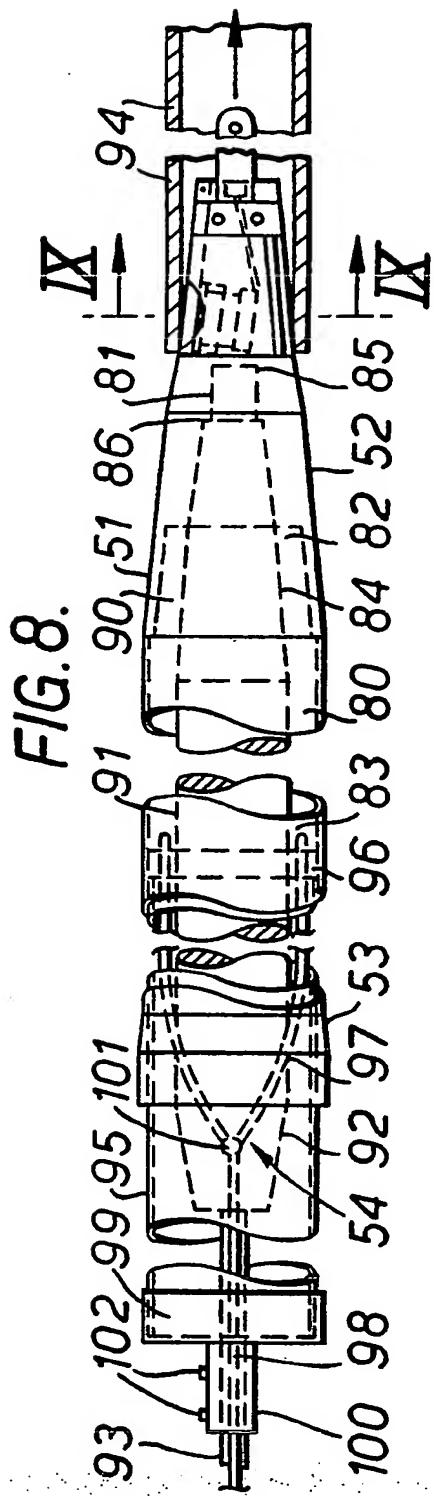
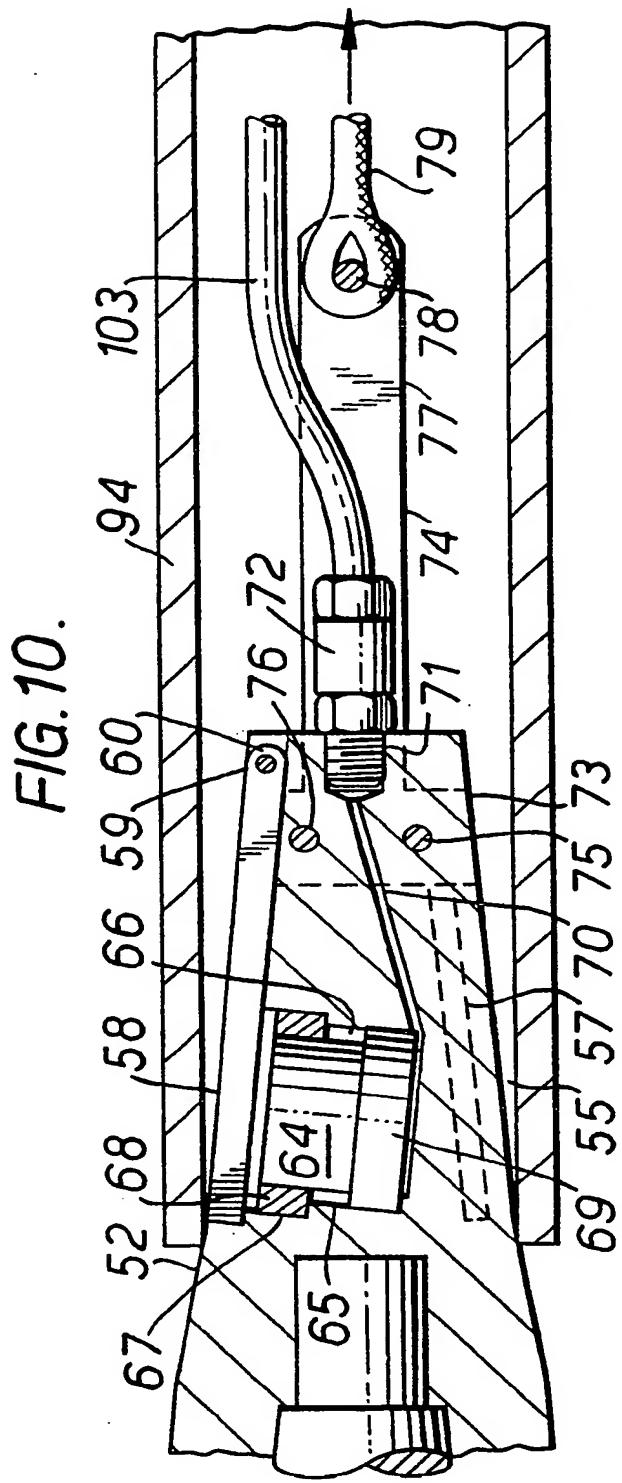


FIG. 9.

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**SPECIFICATION**  
**Pipe replacement system**

The present invention relates to the replacement or the preparation for replacement of an existing main, particularly an existing cast iron gas main, with a new main and is particularly concerned with a method and a device for enabling this replacement to be carried out.

Mains have to be replaced for a number of reasons, for instance, the existing main may be in poor condition or the existing main may not be of sufficient capacity to accommodate a modified load.

The usual means of replacing a gas main involves the use of costly and labour intensive total excavation of the surrounding ground. Alternatively, if total excavation is avoided and the new main is merely inserted into the existing main, it will, by necessity, be of smaller internal diameter than the existing main and thus will be of smaller gas carrying capacity.

It is an object of the present invention to enable an existing main to be replaced or prepared for replacement by a new main without any of the above disadvantages.

According to one aspect of the present invention, there is provided a method for replacing or preparing for replacement an existing main with a new main, the method comprising fracturing the existing main and maintaining sufficient clearance through the fractured main for movement therethrough of a new main or a liner for the fractured main, the liner to serve as a protective sleeve for the new main when the new main is subsequently moved into the liner.

Embodiments of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a side view of a first embodiment of the mole shown in use,

Figure 2 is an end view of the mole cutting face shown in Figure 1 and having four cutting edges,

Figure 3 is an end view of the mole cutting face shown in Figure 1 and having three cutting edges,

Figure 4 is a side view partly in section of a second embodiment of the mole shown at the commencement of operation,

Figure 5 is a view of the mole shown in Figure 4 during operation,

Figure 6 is an end view of the mole cutting face shown in Figures 4 and 5 and having three cutters shown in hidden detail and

Figure 7 is an end view of the mole cutting face shown in Figures 4 and 5 having four cutters shown in hidden detail.

Figure 8 is a side view of a third embodiment of the mole shown in use and broken away in part to reveal internal detail,

Figure 9 is a view along the lines IX—IX of Figure 8 and

Figure 10 is a close up view of the front of the mole partly in section.

Referring to the Figures 1 to 3, Figure 1 shows a steel mole 1 having a front portion consisting of

65 a head portion 2 and a cylindrical body portion 3 and a rear portion having clamping means 4 for clamping a new main.

The head portion 2 has a cutting face 5 comprising three or more cutting edges 6 formed by grinding high tensile steel cutters 7 (four cutters are shown in Figures 1 and 2). The cutters 7 are housed in keyways (not shown) in the head portion 2, which is in the form of a cylinder tapering towards the front end of the mole, the cutters 7 being attached to the head portion 2 by means of bolts (not shown) so that the cutters 7 are removable from the head portion 2. The cutting face 5 tapers radially inwardly in the direction of the forward end of the mole 1, that is, the radii of the cutting edges 6 decrease towards the forward end of the mole 1 so as to enable the cutting face 5 to exert a continuously increasing cutting action on the existing main 8 as the mole 1 moves therethrough.

70 75 80 85 90 95 100 105 110 115 120 125

The cutting face 5 terminates at rearward points 9 on the head portion 2, which points 9 are concentrically aligned with the periphery of the body portion 3 and the keyways are arranged on the head portion 2 so that the cutters 7 and their cutting edges 6 in position on the mole 1 lie in an axial plane of the mole 1.

The front end of the head portion 2 is provided with a housing 10 cast into the head portion 2 and provided with an eye 11 to enable the mole 1 to be connected to a steel winch cable (not shown).

The rear portion of the mole 1 is provided with a clamping means 4 in the form of a sleeve 12 secured to the body portion 3 and being of slightly smaller external diameter than that of the body portion 3. The sleeve 12, in use, receives the ends of the new main 13 which is of a flexible material such as plastics. The end of the new main 13 is first surrounded by a protective plastics sleeve 14 and the main 13 and sleeve 14 are pushed into the clamping sleeve 12. This is arranged to have an internal diameter approximately equal to the external diameter of the new main 13 so that this fits securely within and is tightly gripped and clamped by the clamping sleeve 12.

110 115 120 125

The cutters 7 are arranged to be spaced equiangularly around the axis of the cutting face 5 as shown in Figures 2 and 3 and the taper of the cutting face 5 prevents the mole 1 from twisting and turning on its horizontal axis thereby preventing undue strain on the new main and associated pneumatic feedlines (not shown).

In use, the ground at either end of the existing cast iron main 8 is excavated to expose those ends. The steel cable of a motorised winch is fed through the main 8 from one end and is secured to the shackle housing 10 via the eye 11. The new plastic main 13 and its sheath 14 are then clamped to the clamping sleeve 12. The new plastics main 13 can be of the same or slightly larger internal diameter than the existing cast iron main 8. The head portion 2 of the mole 1 is then inserted into the existing cast iron main 8 until the cutting edges 6 engage the end of the main 8 as shown in Figure 1.

The cable is then wound onto the winch so as to pull the mole 1 through the existing main 8. At the same time the rear portion 12 is acted upon by a pneumatic hammer (not shown) to drive the mole 1 into the main 8. The combined tension and pneumatic pressure cause the mole 1 to move along the main 8 so that the cutting edges 7 engage the internal wall of the main 8 and cause the wall to fracture due to their intense localised pressure on the wall as the mole 1 moves therethrough. The cylindrical body 3 widens out the internal diameter of the fractured main 8 since, in use, the body 3 is selected to have a diameter greater than that of the original internal diameter of the main 8. The body 3 also prevents debris from the fractured main and earth from falling into the pathway created for the new main. As the mole 1 proceeds along the new fractured main 8 it tows the new main 13 and its associated sheath 14 with it, the internal diameter of the new main 13 being equal to or slightly larger than that of the existing main 8. When the new main 13 is finally in position, the new main 13 and its sheath 14 are removed from the clamping sleeve 12.

As a general rule the outer diameter of the body portion 3 of the mole 1 is arranged to be about 1/8" greater than the outer diameter of the existing main and the outer diameter of the clamping sleeve 12 is about 1/8" less in diameter than that of the cylindrical body portion 3 of the mole 1.

Referring to Figures 4 to 7, Figure 4 shows a steel mole 21 having a front portion consisting of a head portion 22 and a body portion 23 and a rear portion having a clamping means 24 for clamping a new main.

The head portion 22 has a cutting face 25 comprising three or more pivotally mounted cutting blades 26 (four are present on the mole shown in Figures 4 and 5). The blades 26 are disposed in elongated axially directed slots (not shown) in the wall of the head portion 23 and are pivotally mounted at their forward ends 27 to the wall of the head portion 23.

Referring to Figures 6 and 7 the blades 26 are arranged to be spaced equiangularly around the axis of the cutting face. Each blade 26 has a cutting edge 28 formed by two sloping sides 29, two parallel sides 30 adjoining the sloping sides 29 and a concave side 31 distal from the cutting edge 28 between the parallel sides 30.

Referring to Figures 4 and 5 the concave side 31 slopes away from the cutting edge 28 in a direction forwardly of the mole 1.

The body portion 23 has a cylindrical rear portion 32, a frustoconical portion 33 tapering forward of the mole and a cylindrical front portion 34 adjoining the slot forming walls (not shown) of the head portion 23.

The body portion 23 is provided with a circular centrally located through-going bore 35 (see Figure 5) which merges with a passageway 36 formed by the concave sides 31 of the blade 26 and the internal concave shaped walls (not shown) of the head portion slot forming walls. The

passageway 36 merges with a circular centrally located through-going bore 37 located near the forward end of the head portion 23 beyond the pivoted ends 27 of the blades 26. The bore 27 is provided with a conical termination 38.

The bore 35 and passageway 36 house an hydraulically operated cylindrical ram 39 which is capable of movement within the bore 35 and passageway 36. The front of the ram 39 is engaged at all times with the concave sides 31 of the blades 26. When the blades 26 are in the closed position shown in Figure 4 the cutting edges 28 are axially aligned with the front portion 34 of the body portion 23. The concave sides 31 of the blades 26 extend further radially into the passageway 36 than do the internal concave shaped walls of the head portion slot forming walls (not shown) so as to permit the blades 26 to pivot outwardly from the closed position in Figure 4 to the open position in Figure 5 as the ram 29 is moved forwardly along the passageway 36 and encounters the radially inward slope of the concave sides 31.

The front end of the head portion 22 is provided with a housing 40 and an eye 41 similar to that shown in the mole of Figure 1 and for similar purposes.

The rear portion of mole 21 is provided with a clamping means 24 in the form of a clamping sleeve 42 similar to that shown in the mole in Figure 1. As in that mole, the clamping sleeve 42 is secured to the body portion 23 and is of slightly smaller diameter than the rear portion 32 of the body portion 23. The new plastics main 43 and its protective sheath 44 are secured and clamped to the clamping sleeve 42 in exactly the same manner as previously described for the mole shown in Figure 1.

In use, as with the mole described in Figure 1, the ground at either end of the existing cast iron main 45 is excavated to expose those ends. The steel cable of a motorised winch is fed through the main 45 from one end and is secured to the housing 40 via the eye 41. The new plastics main 43 and its sheath 44 are then clamped to the clamping sleeve 42. The new plastics main 43 can be of the same or slightly larger internal diameter than the existing cast iron main 45. The head portion 22 of the mole 21 is then inserted into the

existing main 45 until a portion at least of the cutting blades 26 lie adjacent to the internal wall of the existing main 45 as shown in Figure 4. The ram 39 is actuated hydraulically to move forwardly within the passageway 36 to cause the blades 26 to pivot about their ends 27 to engage and fracture the cast iron main 45 by the intense localised pressure of their cutting edges 28 upon the internal wall of the main 45 as shown in Figure 5. After a portion of the main 45 has been cracked

open the ram 39 is withdrawn to the position shown in Figure 4 so that the blades 26 return to the closed position of Figure 4. The winch cable (not shown) is then wound onto the winch so as to pull the mole 21 through the existing main 45 by an amount not exceeding the length of the blades

26. A next portion of the existing main 45 is then fractured by the method just described and the mole 21 is then pulled through the main 45 by a further amount not exceeding the length of blades

5 26. This process is repeated until the entire length of the existing main 45 has been fractured. As the mole 21 moves through the fractured main 45 the body portion 23 widens out the internal diameter of the fractured main 45 since, in use, the rear

10 portion 32 of the body portion 23 is selected to have a diameter greater than that of the original internal diameter of the cast iron main 45.

The body portion 23 also prevents debris from the fractured main 45 and earth from falling into the pathway created for the new main 43. As the mole 21 proceeds along the fractured main 45, it tows the new main 43 with it the internal diameter of the new main 43 being the same or slightly larger than that of the existing main 45.

20 When the new main 43 is finally in position, the new main 43 and its sheath 44 are removed from the clamping sleeve 42.

Referring to Figure 8, the steel mole 51 comprises a front portion consisting of a head 52 tapering generally conically towards its front end and a cylindrical rear portion 53 incorporating clamping means 54 for clamping a cylindrical liner for the new main.

As shown more clearly in Figures 9 and 10 the head portion 52 has a cutting face 55 comprising three blades 56, 57 and 58 disposed in elongated axially directed slots in the wall of the head 52. Two lower blades 56 and 57 (shown in Figure 9) are attached rigidly in the slots so that they are fixed.

The other upper blade 58, which is wider and thicker than the lower blades, is pivotally mounted at its forward end 59 to the wall of the head portion 52.

40 The upper blade 58 pivots on a pin 60 extending through portions (not shown) of the head 52 of the mole 51, the portions forming a recess (not shown) to accommodate movement of the blade 58.

45 As shown in Figure 9, the blades 56 to 58 are spaced equiangularly around the axis of the cutting face which tapers forwardly to the front end of the mole 51. Each blade 56 to 58 has a cutting edge 60 formed by two sloping sides 61 and a base 62 distal from the cutting edge 60 and formed between parallel sides 63.

50 Referring to Figures 9 to 10 the head 52 of the mole 51 houses an hydraulically actuated piston 64 slideable within a cylindrical bore 65 within the head 52. The bore 65 has a portion in which the piston 64 is slideable. An internally threaded cylindrical recess 67 is located above the portion 66 and receives an externally threaded stop ring 68. The stop ring 68 serves to limit the extent of upward movement of the piston 64 when it engages with a lowermost stop collar 69 forming an integral part of the piston 64.

55 As shown in Figures 8 and 10 the head 52 is provided with a hydraulic fluid channel 70 which at one end communicates with the bore 65 below

the piston 64 and terminates in a threaded bore 71 of wider diameter at the front end of the head 52. The threaded bore 71 serves to receive the threaded connector of a hydraulic hose

70 coupling 72.

While not shown, the front end of head 52 is recessed laterally on two sides to receive and engage the crosspieces 73 of two adjacent T-shaped winch cable connecting plates 74 (only 75 one plate 74 shown in the drawings). The plates 74 are connected to each other and to the front end of the head 52 by a pair of connecting pins 75 and 76 which extend through the cross-pieces 73 of the plates 74 via the front end of the head 80 portion 52. The uprights 77 of the connecting plates 74 extend forwardly of the mole 51 and are connected together by a pin 78 which also forms a connecting point for the cable 79 of a winch (not shown).

85 Referring to Figure 8, the rear 53 of the mole 51 comprises a generally hollow cylinder adjoining the conically tapering molehead 52. The mole 51 forms a housing for a pneumatically actuated hammer device 80.

90 The hammer 80 has head portion 81 projecting into an internal bore 82 formed in the head 52 of the mole 51, the rear 83 of the hammer 80 being axially disposed with clearance in the cylindrical rear portion 53 of the mole 51.

95 The head portion 81 of the hammer 80 comprises a forwardly conically tapering portion 84 terminating in a cylindrical end 85. The diameter of the end 85 is less than the diameter of the adjoining end of the conically tapering portion 84 so that there is an annular shoulder 86 formed between the portion 84 and the hammer end 85.

100 As shown in Figure 8 the portion 84 and the end 85 of the hammer head 81 are, in use, able to cooperatively engage in corresponding portions of 105 the internal bore 82, these portions also forming an annular shoulder for cooperation with the annular shoulder 86 in the hammer head 81. A rear part of the hammer portion 84 is disposed axially with clearance in a wider forwardly 110 conically tapering portion 90 of the internal bore 82, the portion 84 terminating within the rear 53 of the mole 51.

115 The rear 83 of the hammer 80 comprises a cylindrical portion 91 terminating in a rearwardly tapering conical portion 92 which is provided with a coupling (not shown) for an air hose 93.

In use, compressed air supplied to the hammer 120 80 through the hose 93 causes the hammer 80 to reciprocate in the conventional manner to drive the mole 51 through the existing main 94 of the percussive action of the hammer head 81 upon the corresponding cooperating portions of the internal bore 8 of the mole 51.

125 The means 54 for clamping the liner 95 to the mole 51 comprises a steel ring 96 for engaging the rear end of the liner 95, a looped cable 97 connected to the ring 96, a tensioning cable 98 connected to the cable 97, a clamping cup 99 for engaging the far end of the liner 95 and a tensioning device 100 for tensioning the cable 98.

The steel ring 96 is secured as by welding within and to the internal wall of the rear portion 53 of the mole 51. The ring 96 is formed with holes (not shown) to enable the ends of the looped steel cable 97 to be secured thereto.

The clamping cup 99 which is also of steel is adapted to receive and locate the far end of the liner 95 and is apertured (not shown) for the passage therethrough of the air hose 93 and of the tensioning cable 98.

The tensioning cable 98 which is also of steel, is coupled by a conventional hitch 101 at one end to the looped cable 97 and is connected via its other end to the tensioning device 10. Tensioning device 100 comprises a ratchet winch arrangement 102.

In use of the mole 51, as with the moles previously described the ground at either end of the existing cast iron main 94 is excavated to expose the ends of the main 94. The steel cable 79 of a motorised winch is then fed through the main 94 from one end and is secured to mole 51 located at the other end of the main 94. The cable 79 is connected to the winch cable plates 74 by way of the winch cable pin 78. Next the hydraulic hose 94 is fed through the same end of the main 94 as the cable 79 and is coupled to the fluid bore 71 in the mole head 52 by way of the hose coupling 72.

In the next stage, the liner 95 is clamped to the mole 51. Initially, the looped cable 97 is secured to the ring 96 and the cable 97 is then secured to the tensioning cable 98. The liner 95 is then pushed up the cylindrical portion 53 of the mole 51 until one end of the liner 95 engages with the ring 96. The clamping cup 99 is then slid along the tensioning cable 98 and the air hose 93 until the other end of the liner 95 is located within and engages with the cup 99. The tensioning cable 98 is then tensioned by the tensioning device 100 and the liner 95 is therefore clamped compressively between the clamping cup 99 and the ring 96.

As shown in Figures 8 and 10 the internal diameter of the liner 95 is greater than the internal diameter of the existing cast iron main 94.

The head portion 52 of the mole 51 is then inserted into the cast iron main 94 until the cutting edges 60 of the blades 56, 57 and 58 engage the end of the main 94 as shown in the drawings. The pneumatic hammer 80 is actuated by supplying compressed air to its rear end by way of the air hose 93 so that the hammer 80 percussively drives the mole 51 through the main 94.

Simultaneously the mole 51 is drawn through the main 94 by the cable 79 which serves to guide the mole 51 axially through the main 94.

As the mole 51 moves through the main 94 the cutting edges 60 engage the internal wall of the main 94 and cause it to fracture. Since the cylindrical portion 53 of the mole 51 has a greater

external diameter than the internal diameter of the main 94, the internal diameter of the fractured main 94 is widened out. The body 53 of the mole 51 also serves to provide clearance for the passage of the liner 95 therethrough and prevents debris from the fractured main and earth from falling into the pathway created for the liner 95.

Should the mole 51 encounter an obstruction in the main 94, such as a pipe joint, the movable blade 58 is pivoted outwardly to fracture the obstruction and provide a clearance for the liner. In this case hydraulic fluid is pumped to the piston 64 via the hose 103, duct 70 and the cylinder bore 65. The fluid pressure is relaxed immediately after the obstruction has been fractured so that the piston 64 relaxes and the blade 58 returns to its closed position. The hose 103 is of course moved simultaneously forward with the mole 51.

The liner 95 is pushed through and out of the main 94 after complete fracture thereof.

Finally the mole 51 together with the associated tensioning device 100 are removed from the liner 95. The new main (not shown) may then be pushed manually or otherwise through the liner 95 which therefore form a protective sleeve for the new main.

The new main may be of any convenient plastics material such as polyethylene or pvc while the liner is of a much tougher wear resistant plastics material.

#### CLAIMS

1. A method for replacing or preparing for replacement an existing main with a new main, the method comprising fracturing the existing main and maintaining sufficient clearance through the fractured main for movement therethrough of a new main or a liner for the fractured main, the liner to serve as a protective sleeve for the new main when the new main is subsequently moved into the liner.

2. A method as claimed in Claim 1 in which the new main is presleeved with the liner before the new main is moved through the fractured main.

3. A method as claimed in Claim 1 or Claim 2 in which the existing main is continuously fractured ahead of the moving new main or liner.

4. A method as claimed in any of Claims 1 to 3 in which the internal diameter of the new main is equal to or greater than the internal diameter of the existing main.

5. A method as claimed in any of Claims 1 to 4 in which the clearance provides a bore whose diameter is greater than the external diameter of the existing main.

6. A method as claimed in any of the preceding claims in which the clearance provides a bore whose diameter is greater than the external diameter of the new main or the liner.

7. A method as hereinbefore described with reference to Figures 1 to 3 or Figures 4 to 7 or Figures 8 to 10.